A NEW SPECIES OF *NOTADEN* (ANURA: LEPTODACTYLIDAE) FROM THE KIMBERLEY DIVISION OF WESTERN AUSTRALIA

By G. M. SHEA* & G. R. JOHNSTON†

Summary

SHEA, G. M. & JOHNSTON, G. R. (1987) A new species of *Notaden* (Anura: Leptodactylidae) from the Kimberley Division of Western Australia. *Trans. R. Soc. S. Aust.* **112**(1), 29–37, 31 May 1988.

Notaden weigeli sp. nov. is described from the northern Kimberley of Western Australia. It is distinguished from congeners by its longer legs (TL/S-V 0.34–0.38 *vs* 0.25–0.34), more prominent subarticular and palmar tubercles, red to fawn dorsum without black markings and lack of a pale mid-rostral streak. The cranial skeleton is very reduced. *N. weigeli* is apparently allopatric to other species of *Notaden* and is associated with rocky habitats.

KEY WORDS: *Notaden*, Anura, new species, morphology, osteology, discriminant function analysis.

Introduction

The known anuran fauna of the Kimberley division of Western Australia currently comprises 38 species, the majority (22 species) having been first described or recorded from the region since 1976. Ten of these species are apparently endemic to the Kimberley or nearly so (Tyler, Smith & Johnstone 1984; Tyler, Davies & Watson 1987). This paper describes a further new species apparently endemic to the Kimberley.

Materials and Methods

Specimens cited here are located in the Australian Museum, Sydney (AM), South Australian Museum, Adelaide (SAM) and Western Australian Museum, Perth (WAM).

All measurements were made to 0.1 mm with a pair of dial calipers. Snout-vent length (S-V), head width (HW), eye diameter (E), eye to naris interval (E-N) and internarial span (IN) are as defined by Hosmer (1962). Head length was not measured. Tibia length (TL) was measured from the heel to the point of the tibial tuberosity, with the leg flexed. Foot length (FL) was measured from the heel to the tip of the fourth toe, with the foot straightened. A single specimen was cleared and double stained for bone and cartilage following the method of Hanken & Wassersug (1981).

Descriptive statistics were calculated for S-V and a number of morphometric ratios (Table 1) from samples of all *Notaden* species. Multiple comparisons of arcsine-transformed ratios were made using single classification ANOVA (Sokal & Rohlf 1981). A multiple discriminant function analysis (Reyment, Blackith & Campbell 1984) of raw measurements was done using SPSS PC+ (Norusis 1986) on a Pantek PC-16 computer. Sexes were pooled for all analyses.

Ontogenetic variation was examined by fitting TL, FL and HW for *N. bennetti, N. melanoscaphus* and *N. nichollsi* to the allometric equation $Y = bS\text{-}V^a$ (Huxley 1932; Gould 1966), where Y is the variable being examined, S-V is used as a measure of overall size, a is the allometric coefficient (slope) and b is a constant. Allometric coefficients were tested against unity using standard normal deviates (Zar 1974).

Notaden weigeli sp. nov.
FIGS 1–9

Notaden sp. nov: Tyler, Davies and Watson 1987, p. 545.

Holotype: WAM R77419, Sandstone Ck, WA, (14°53'30"S 125°45'00"E), collected by C. Kemper on 26.x.1981.

Paratypes: AM R123896–99, Mitchell Plateau, WA, (14°51'S 125°40'E), J. Weigel, G. Shea and A. Harwood, 6–8.i.1987; WAM R83428–29, 23 km NW old Mount Elizabeth HS, WA (16°12'S 126°00'E), H. Ehmann and G. R. Johnston, 29.xi.1982.

Diagnosis: Notaden weigeli differs from all other *Notaden* species in its longer legs (TL/S-V 0.34–0.38 *vs* 0.25–0.34), more prominent subarticular and palmar tubercles, red to fawn dorsum without black markings and lack of a pale mid-rostral streak.

Description of holotype: Size large (S-V 54.4 mm). Head small, as broad as long, length approximately ¼ S-V (Fig. 1). Snout truncated when viewed from above; high and bluntly rounded in profile (Fig. 2). HW/S-V 0.30. Nostrils superior. Eye-naris interval equal to internarial span (E-N/IN 1.00). Nostrils nearer to tip of snout than to eye. Canthus rostralis poorly defined, very short. Eye prominent (E/S-V 0.13), diameter approximately twice E-N. Tympanum covered by glandular skin. Maxillary and vomerine teeth absent. Tongue oval.

* Department of Veterinary Anatomy, University of Sydney, NSW 2006.
† C/- 16 McEwin Street, Whyalla Playford, S. Aust. 5600.

TABLE 1. *Comparative morphometrics of post-metamorphic specimens of* Notaden *species. Values are given as* $\bar{x}$ *(SD) over range.*

	N. bennetti	*N. melanoscaphus*	*N. nichollsi*	*N. weigeli*
N	22	40	49	7
S-V (mm)	38.4 (14.83) 20.7-67.4	43.3 (6.25) 27.9-50.7	46.2 (5.68) 37.9-60.4	57.0 (10.05) 46.6-71.1
TL/S-V	0.29 (0.02) 0.25-0.34	0.28 (0.02) 0.25-0.34	0.29 (0.01) 0.26-0.32	0.35 (0.01) 0.34-0.38
FL/S-V	0.50 (0.04) 0.43-0.59	0.51 (0.04) 0.40-0.61	0.53 (0.03) 0.49-0.59	0.58 (0.03) 0.55-0.64
HW/S-V	0.31 (0.03) 0.26-0.34	0.29 (0.02) 0.25-0.34	0.29 (0.02) 0.25-0.33	0.29 (0.02) 0.25-0.31
E-N/S-V	0.06 (0.01) 0.04-0.09	0.06 (0.01) 0.04-0.08	0.05 (0.01) 0.04-0.06	0.06 (0.01) 0.05-0.08
E-N/IN	0.98 (0.12) 0.75-1.25	1.17 (0.18) 0.92-1.65	0.83 (0.08) 0.68-1.00	1.18 (0.23) 1.00-1.59
E/S-V	0.12 (0.01) 0.10-0.14	0.11 (0.01) 0.10-0.13	0.14 (0.01) 0.11-0.17	0.11 (0.02) 0.09-0.13

Fingers moderately long, unwebbed, cylindrical, without lateral fringes (Fig. 3); finger length $3>1>2\geq4$. Tips of fingers slightly dilated. Subarticular tubercles large and sharply defined proximally, poorly defined to absent distally; several moderately large, rounded palmar tubercles.

Hind limbs short (TL/S-V 0.34; FL/S-V 0.58); toe lengths $4>3>5>2>1$; toes with weak lateral fringes and basal webbing, reaching to base of antepenultimate phalanx of fourth toe (Fig. 3); subarticular tubercles prominent at base of toes, poorly defined to absent distally. Outer metatarsal tubercle absent; inner metatarsal tubercle large, projecting, shovel-shaped with smoothly rounded free margin, length approximately equal to its distance from tip of first toe.

Skin of dorsal and lateral surfaces of body and head thickened, pustulose to tubercular (Fig. 1);

Fig. 1 *Notaden weigeli* sp. nov. (Mitchell Plateau) in life. (Photograph: J. Weigel).

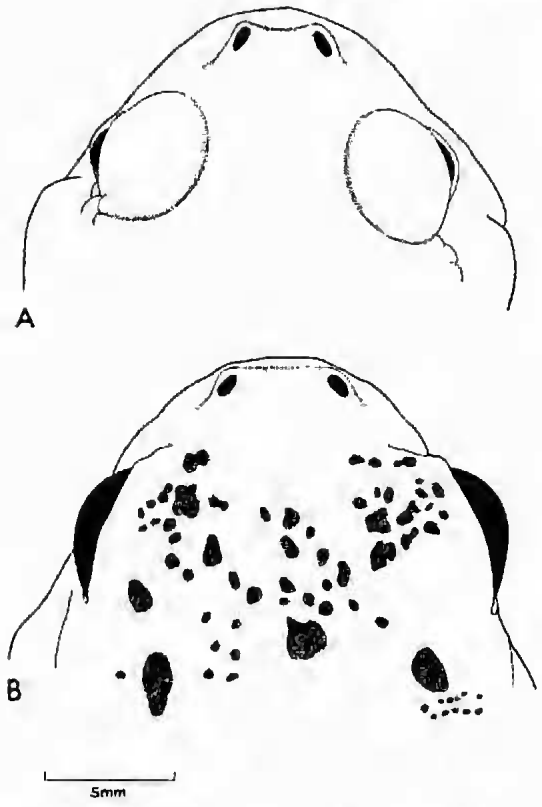

Fig. 2. Dorsal view of heads of A, *Notaden weigeli* sp. nov. and B, *N. nichollsi*.

snout more finely and weakly tubercular; a distinct crease from commissure of lips to lateral canthus of eye, bordered posteriorly by a broad ridge. Individual glands obvious subdermally on posterolateral margins of body. Skin extends from body to knee laterally, so that groin is not distinct in life. Skin on ventral surfaces smooth.

In preservative, dorsum of head and body reddish brown, obscurely marbled with lighter and darker shades, and with a few white to cream tubercles. Limbs dark grey, with prominent to obscure white or cream flecks. Face and upper lips dark grey, finely variegated and flecked with cream; pale midrostral streak absent; pale vertical canthal streak weakly developed. Venter cream, with weak brown flecking on mandible. Inner metatarsal tubercle unpigmented.

Measurements of holotype (in mm): S-V 54.4, TL 18.7, FL 31.6, HW 16.5, E. 7.0, E-N 3.0, IN 3.0.

Variation

Overall variation in limb and cranial proportions is presented in Table I.

The Mitchell Plateau paratypes are similar to the holotype, ranging in size from 46.6 to 60.8 mm. In preservative, the dorsal ground colour is fawn. The pale dorsal tubercles and canthal streak are absent on some specimens.

Gravid females have 1.3 mm diameter oocytes with black animal poles and white vegetal poles.

The two Mount Elizabeth Stn paratypes are very much larger than the Mitchell Plateau series (S-V 68.7–71.1 mm), and have a longer snout (E-N/S-V 0.07–0.08 *vs* 0.05–0.06, E-N/IN 1.42–1.59 *vs* 1.00–1.12). However, in other characters, including all significant diagnostic characters, they agree with the topotypic sample.

Color in life (based on AM R123896-99): Dorsum fawn with numerous white-tipped orange tubercles and scattered indistinct grey-green patches. Limbs grey with a few fine white tubercles above, sharply demarcated from fawn of dorsum. Hindlimb also with a few small orange flecks. Face grey with white tubercles. Venter greyish. Inner metatarsal tubercle unpigmented.

Pupil horizontally elliptic, with a distinct ventral notch. Iris finely variegated golden green with a gold pupillary margin.

Osteology (based on AM R123898)

Cranium poorly ossified (Fig. 4). Sphenethmoid not ossified either dorsally or ventrally, cartilage extending ¼–⅓ length of orbit in dorsal view.

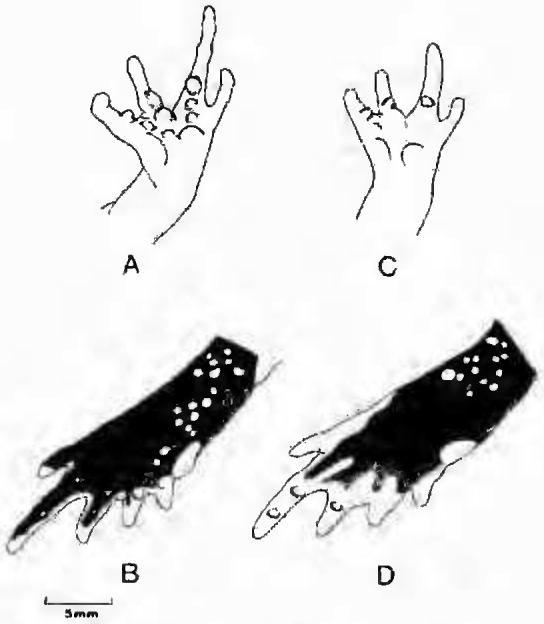

Fig. 3. A, B, Hand and foot of *Notaden weigeli* sp. nov.; C, D, hand and foot of *N. nichollsi*.

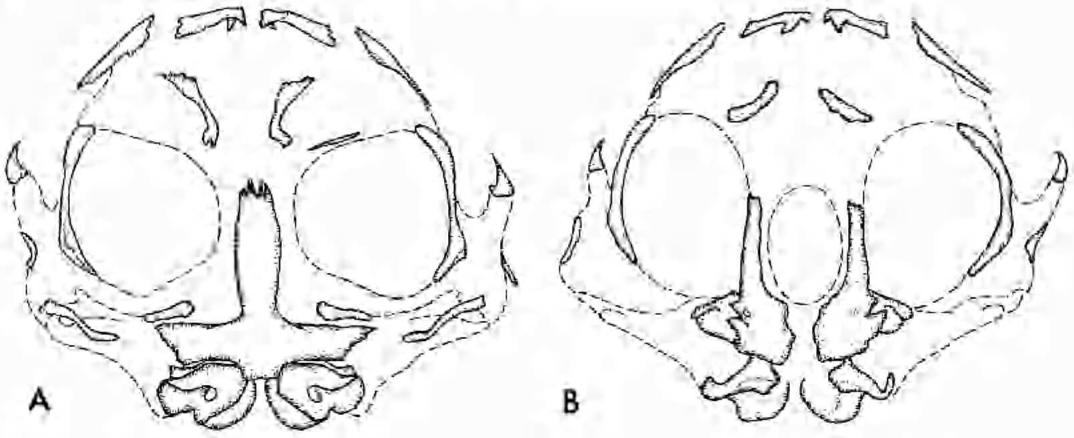

Fig. 4. A, ventral and B, dorsal views of skull of *Notaden weigeli* sp. nov. Approximate extent of some cranial cartilages and frontoparietal fontanelle indicated by dashed lines.

Exoccipitals and prootics paired, unfused. Crista parotica non-ossified, moderately long, robust. Frontoparietal fontanelle fully exposed, ovoid. Frontoparietals poorly ossified, anterior extremities slender, parallel, extending anteriorly ¼ length of orbit. Anterior margin of frontoparietal fontanelle formed by cartilaginous sphenethmoid, posterior margin formed by prootic cartilage. Nasals small, widely separated, not in osseous contact with any other cranial bones. Palatines very reduced to absent (represented by a sliver of bone on left, absent on right). Parasphenoid robust, with broad, moderately long and terminally bifid cultriform process; alae moderately short, broad, at right angles to cultriform process. Pterygoid reduced; anterior ramus not contacting maxilla; medial ramus short, slender, well ossified; posterior ramus minute. Quadratojugal reduced, widely separated from maxilla. Squamosal reduced, with long acuminate zygomatic ramus and lacking otic ramus. Maxilla reduced, edentate; pars facialis shallow, with low, poorly developed preorbital process, widely separated from nasals. Alary process of premaxilla narrow, tall, acuminate and vertical; pars palatina very shallow; palatine process short. Vomers reduced, with narrow elongate edentate dentigerous process; alae bordering rostral margin of choanae. Columella long, sinuous, with a medial posterior convexity and lateral anterior convexity; ossified medially.

Hyoid plate slightly broader than long (Fig. 5). Anterior hyale without anteromedial process. Alary process pedunculate, without distal expansion. Posterolateral process prominent, dilated distally. Posterior cornu ossified, with a distal cartilaginous expansion.

Pectoral girdle arciferal and robust (Fig. 6). Epicoracoid cartilages broadly overlapping. Omosternum cartilaginous, dilated distally. Xiphisternum, mesosternum present, cartilaginous. Clavicles moderately robust, curved, moderately separated medially. Coracoids robust, moderately separated medially, broadly expanded at both ends. Scapula bicapitate, approximately 1.5x length of clavicle. Suprascapula ossified anteriorly, with a hook-like cartilaginous process projecting posteroventrally.

Phalangeal formula of manus 2.2.3.3. Terminal phalanges pointed, slightly knobbed distally, recurved. Carpus poorly ossified. Prepollex cartilaginous.

Eight non-imbricate presacral vertebrae (Fig. 7). Vertebrae I and II fused; centra of vertebrae II and III fused. Cervical cotyles very narrowly separated, almost confluent. Neural arches completely ossified, robust. Relative widths of transverse processes

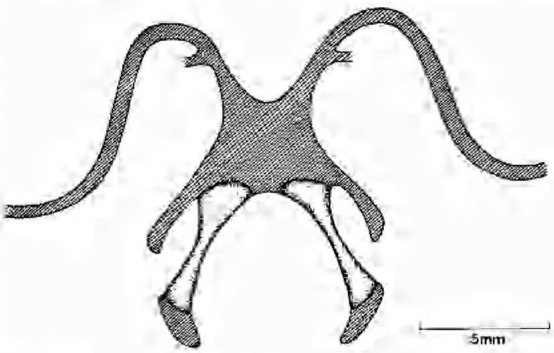

Fig. 5. Hyoid of *Notaden weigeli* sp. nov. Hatched areas are cartilage.

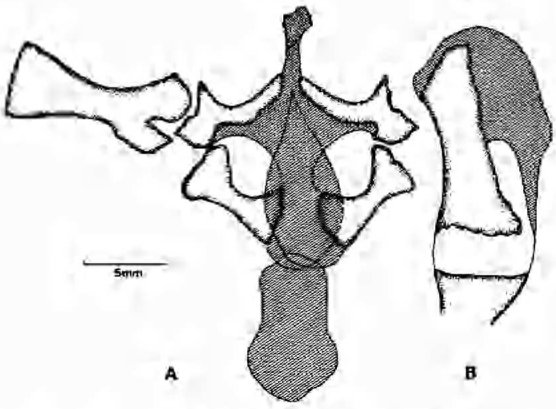

Fig. 6. Pectoral girdle of *Notaden weigeli* sp. nov.: A, sternal region, B, left suprascapula. Hatched areas are cartilage.

sacrum > III > IV > II = V = VI > VII > VIII > I. Sacral diapophyses moderately expanded. Bicondylar sacrococcygeal articulation. Well-developed dorsal crest along anterior third of urostyle.

Ilium with well-developed dorsal prominence bearing a shallow notch on dorsal margin (Fig. 8). Dorsal protuberance small. Ilial shaft round in section, moderately curved. Pubis largely cartilaginous, slightly calcified ventrally. Ischium with a well-defined vertically ovoid ossification.

Phalangeal formula of pes 2.2.3.4.3. Well-developed cartilaginous prehallux reinforcing inner metatarsal tubercle. Distal tarsal elements poorly ossified.

Etymology

This species is named after Mr John Weigel of Gosford, NSW, co-collector of the Mitchell Plateau paratypes, in honour of his efforts to promote amateur herpetology in Australia.

Comparison with other species

Distribution: Notaden weigeli is apparently allopatric to its three congeners: *N. bennetti* Günther, *N. melanoscaphus* Hosmer and *N. nichollsi* Parker (Cogger 1986; Tyler, Smith & Johnstone 1984; Tyler & Davies 1986). Within the Kimberley Division, *N. nichollsi* is largely confined to the southwest and south, *N. melanoscaphus* to the far east, with a single record from the central Kimberley, and *N. weigeli* to the north (Fig. 9). Known localities for *N. weigeli* are separated from those of *N. melanoscaphus* by 87 km and from those of *N. nichollsi* by 188 km.

External morphology: In addition to the characters given in the diagnosis, *N. weigeli* differs from *N. bennetti* in having a reddish dorsum without black tubercles (*vs* yellow dorsum with rounded black and red tubercles arranged in vertebral and transverse series) and inner metatarsal tubercle subequal in length to its distance from tip of first toe (*vs* 1.2–2.0 times as long; Parker 1940).

N. weigeli further differs from *N. melanoscaphus* in having an unpigmented inner metatarsal tubercle (*vs* black) and in lacking large discrete islands of

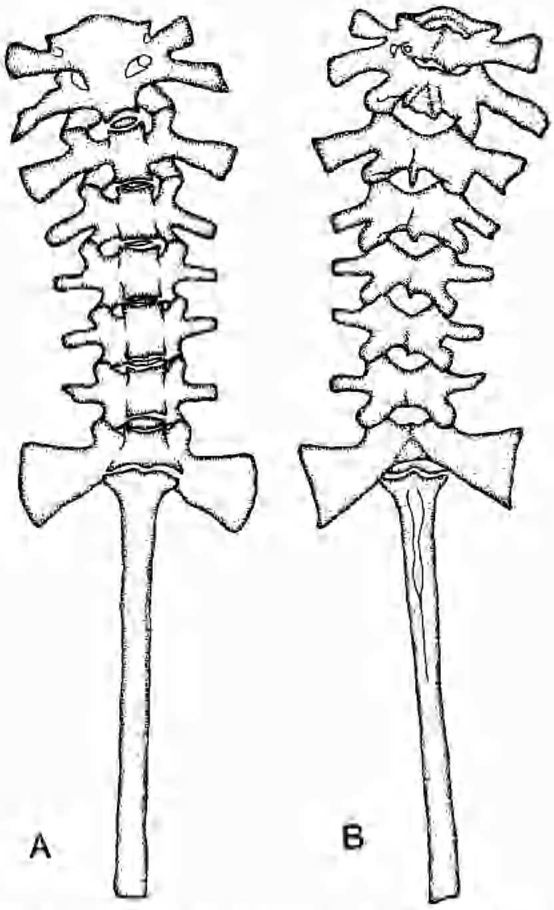

Fig. 7. A, Ventral and B, dorsal views of vertebral column of *Notaden weigeli* sp. nov.

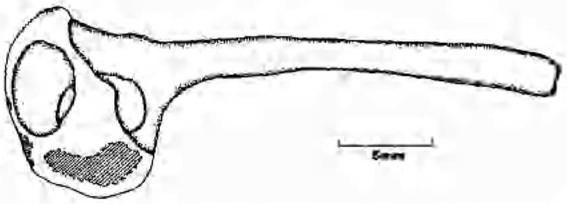

Fig. 8. Pelvis of *Notaden weigeli* sp. nov. Hatched areas are calcified.

dark pigmentation on the back (cf. Hosmer 1962; Tyler, Smith & Johnstone 1984, Plate 4; Tyler & Davies 1986, Plate 40).

N. weigeli further differs from *N. nichollsi* in lacking black tubercles on the body, and in having more narrowly spaced nostrils (Table 1).

Osteology: Few comparative data have been published on the osteology of other *Notaden* species. The skull of *N. nichollsi* has been figured by Lynch (1971 Figs. 18, 56, 57), who also described a number of posteranial characteristics in his diagnosis of the genus, based on *N. bennetti* and *N. nichollsi*. However, there are several discrepancies in Lynch's osteological descriptions and figures of *Notaden* that suggest that re-examination of the osteology of these species is warranted.

The ossified portions of the skull of *N. weigeli* are even more reduced than in *N. nichollsi* and *N. melanoscaphus* (M. Davies pers. comm.). This reduction is most notable in the loss of ossification of the sphenethmoid and palatines, and the reduction of the anterior extremities of the frontoparietals. The apparent lack of distal dilations of the alary processes of the hyoid of *N. weigeli* is consistent with Tyler's (1972) observations on congeners. The fusion of the centra of the second and third presacral vertebrae present in the *N. weigeli* specimen examined has not been recorded for other *Notaden* species, but may be an individual anomaly. The transverse processes of the more posterior presacral vertebrae, while short, are not knob-like (cf. Lynch 1971, p. 56).

The ilia of *N. nichollsi* and *N. melanoscaphus* are illustrated and described by Lynch (1971) and Tyler (1976). The round ilial shaft of *N. weigeli* resembles that of congeners.

Discriminant function analysis: Discriminant function analysis of seven measurements, using species of *Notaden* as *a priori* groupings, resulted in the correct identification of 93.2% of specimens overall. All *N. weigeli*, 95% of *N. melanoscaphus*, 93.9% of *N. nichollsi* and 86.4% of *N. bennetti* were correctly grouped.

The first two discriminant functions accounted for 92.45% of the variance (Table 2). Unstandardised discriminant function coefficients and their correlations with the discriminant functions are presented in Table 2. All characters show the highest correlation with the second discriminant function, which most clearly separates *N. weigeli* from its congeners (Fig. 10).

Allometry: In *N. bennetti, N. melanoscaphus* and *N. nichollsi*, HW showed significant negative allometry. In *N. nichollsi*, TL and FL also show negative allometry (Table 3). The ratio of E–N/IN, however, varied independently of S-V in all three species ($R^2 \leq 0.04$). Comparisons of HW, TL and FL between species should therefore be made between similar-sized specimens. The frequency distribution of S-V varied significantly between the samples of each taxon used here ($F_{3,114} = 10.1062$, $P < 0.01$). Consequently, although ratios showed significant differences (P's < 0.01; Table 1) between taxa, it is unclear whether these differences are real or an artefact of unequal size frequencies between samples.

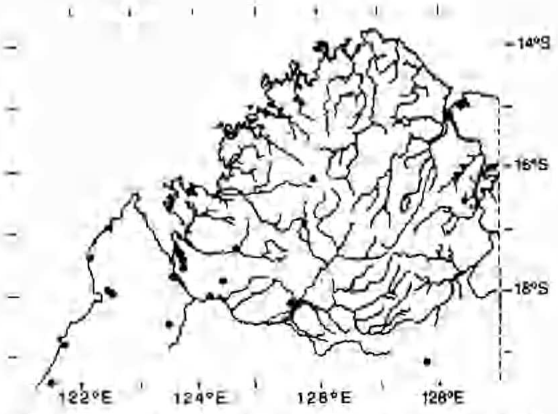

Fig. 9. Distribution of *Notaden weigeli* sp. nov. (triangles), *N. melanoscaphus* (inverted triangles) and *N. nichollsi* (dots) in the Kimberley region (based on SAM and WAM records).

TABLE 2. *Unstandardised discriminant function coefficients (and pooled-within-groups correlations with discriminant functions) of seven characters from all species of* Notaden.

Variable	Discriminant Function I	II	III
S-V	−0.651 (0.071)	−0.267 (0.302)	0.125 (0.233)
HW	−0.949 (0.098)	−0.322 (0.333)	−0.438 (0.164)
E	1.301 (0.334)	0.847 (0.490)	0.911 (0.287)
E–N	−1.514 (−0.159)	0.106 (0.313)	2.355 (0.306)
IN	5.353 (0.353)	1.383 (0.398)	−1.426 (0.118)
TL	−0.520 (0.042)	0.917 (0.560)	−1.370 (0.076)
FL	−0.137 (0.074)	0.258 (0.545)	0.630 (0.307)
constant	−2.963	−3.161	−3.931
% of variance	67.93	24.51	7.55

Habits and habitat

The holotype was collected in open low woodland of *Planchonia australis, Xanthostemon paradoxus, Buchanania obovata* and *Eucalyptus brachyandra* over open scrub and hummock grasses on rugged sandstone (Kitchener *et al.* 1981).

The Mount Elizabeth Stn paratypes were collected between 2030–2400hr within and near the entrance to a small gorge in an isolated 4–6 m high quartzite outcrop. Open *Eucalyptus* spp woodland with negligible understorey and a groundcover of grasses and forbs surrounded the outcrop. The gorge itself was overgrown with *Mimosa*. Isolated clumps of *Pandanus* occurred on drainage channels associated with the outcrop. Both specimens were active after light rain on rock ledges covered with leaf litter.

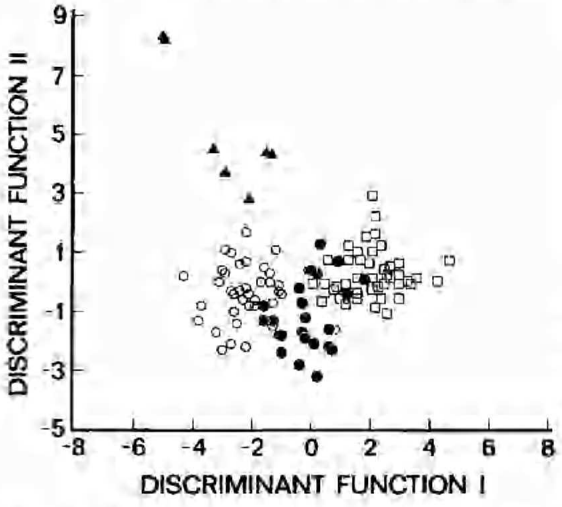

Fig. 10. Plot of individual *Notaden weigeli* sp. nov. (triangles), *N. bennetti* (dots), *N. melanoscaphus* (open circles) and *N. nichollsi* (open squares) on the first two discriminant function axes.

The Mitchell Plateau paratypes were collected within 200 m of the Mitchell River. The habitat at this site consists of a yellow sandplain with densely packed, small to moderate-sized *Plectrachne* and *Triodia* tussocks and an open woodland of tall shrubs and trees dominated by *Eucalyptus* spp and *Acacia* spp. There are numerous, extensive quartzite rock platforms, often with clifflike margins, raised up to 3 m above the level of the plain, bearing scattered *Plectrachne* tussocks on a skeletal sandy soil. Closer to the Mitchell River, these rock platforms are higher (up to 6m), their bases riddled with rock shelters and narrow tunnels, and the sandplain is reduced to narrow sand drifts with numerous partially buried boulders and smaller stones. The bed and bordering overflow area of the Mitchell River consists of a bare sheet of rock with several steps and scattered piles of waterworn boulders, and *Pandanus* and *Melaleuca*-fringed pools. Specimens were active at night, in a puddle on top of a raised rock platform (AM R123897), on a low rock platform partially buried by coarse river sand and surrounded by dense *Triodia* thickets (AM R123898), and on a rock ledge 1.5 m above the surrounding sandplain, following light rain two days previously (AM R123896).

One individual was observed to run rapidly in a zig-zag fashion for more than 10 m on a rock platform at night when being photographed. Similar behaviour has been reported for *N. melanoscaphus* and *N. nichollsi* (Tyler & Davies 1986).

TABLE 3. *Allometric coefficients and calculated values for limb lengths and head width in* Notaden *spp. Regression lines are of the form* $y = bS\text{-}V^a$. C_{40} *and* C_{60} *values are calculated proportions of S-V at 40 and 60 mm. Probabilities are based on standard normal deviates of the allometric coefficient compared to isometry.*

	R^2	*a*	*b*	n	P	C_{40}	C_{60}
			Notaden bennetti				
TL	0.95	0.9615	0.3286	22	0.227	.29	.28
FL	0.96	0.8913	0.7294	22	0.006	.49	.47
HW	0.97	0.7782	0.6797	22	<0.001	.30	.27
			Notaden melanoscaphus				
TL	0.86	1.0595	0.2265	40	0.192	.28	.29
FL	0.82	0.9643	0.5859	40	0.316	.51	.51
HW	0.81	0.7350	0.7761	40	<0.001	.29	.26
			Notaden nichollsi				
TL	0.84	0.7448	0.7677	49	<0.001	.30	.27
FL	0.83	0.7886	1.1800	49	<0.001	.54	.50
HW	0.79	0.8342	0.5493	49	0.004	.30	.28

Collection of these specimens in rocky situations suggests that *N. weigeli* may not burrow to the same extent as its congeners (Lucas & le Souëf 1909; Slater & Main 1963; Mebs 1975; Barker & Grigg 1977; Tyler, Crook & Davies 1983).

When handled roughly, all *N. weigeli* specimens we collected exuded from the dorsal surface a viscous sticky white secretion, which rapidly dried like glue on surfaces exposed to it. Similar exudates have been reported for other *Notaden* species (Lucas & le Souef 1909; Parker 1940; Main & Storr 1966; Mebs 1975; Barker & Grigg 1977; Tyler, Crook & Davies 1983; Tyler, Smith & Johnstone 1984; Tyler 1987).

Faeces from the Mitchell Plateau paratypes consisted almost entirely of remains of the ant *Crematogaster* sp. (Myrmicinae; sample deposited in Australian National Insect Collection, Canberra). This species of ant was common in caves and amongst rocks in the area, and rapidly attacked and killed any frogs and small lizards held in open-weave cloth bags or thin plastic bags. The gorge from which the Mount Elizabeth Stn paratypes were collected was so heavily populated with ants that field work was extremely uncomfortable; no other reptiles or amphibians were found there, despite an extensive search at night and during daylight hours. The secretion produced by *N. weigeli* may play a role in resisting the attacks of the ants on which it feeds.

Myrmecophagy has been recorded in congeners (Lucas & le Souëf 1909; Parker 1940; Calaby 1960) although the prevalence of ants in the diet has been interpreted as an artefact of food availability at times of emergence (Calaby 1960).

Comparative material examined

N. bennetti: AM R11779, "The Plains", Nyngan, NSW; R32163, Murrumbidgee River nr Hay, NSW; R45628, R51216, R51218-20, 16–32 km S Condobolin on West Wyalong Rd, NSW; SAM R3684, 23.3 km S St George, Qld; SAM R4736-38, nr Rockhampton, Qld; SAM R15224a-i, R17617-18, Coonamble, NSW.

N. melanoscaphus: AM R53462, R53569-71, R53573, R53591-92, R53703, Caranbirini Waterhole, 21 km N McArthur River camp, NT; SAM R9663-97, SAM R9669, Strathgordon HS, Qld; SAM R9695-96, Edward River Stn, Qld; SAM R16536-37, Stonewall Ck, 19–26 km NE Lake Argyle, WA; SAM R17904a–e, 0.4 km S Jabiru, NT; SAM R27676-79, 15 km S Northern/Duncan junction, WA; SAM R27680-92, 29 km S Northern/Duncan junction, WA.

N. nichollsi: AM R26002-05, nr The Granites, NT; R49375, R49444-67, R49599-604, 25 km NW Refrigerator Bore, NT; R51653-55, 38.1 km N Neale Junction, WA; R60346, Elliott, NT; R96371-76, 47.6 km SE The Granites by rd, NT; R100739, 4.6 km S of turnoff to Nita Downs on Northern Hwy, WA; R10616-18, 8 km N Mirrica Bore, "Ethabuka", NW Bedourie, Qld.

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THE GENUS ARTHROCARDIA (CORALLINACEAE: RHODOPHYTA) IN SOUTHERN AUSTRALIA

BY H. B. S. WOMERSLEY & H. W. JOHANSEN†*

Summary

Two taxa of *Arthrocardia* Decaisne (tribe Corallineae, subfamily Corallinoideae) occur in south-eastern Australia: *A. wardii* (Harvey) Areschoug and *A. flabellata* (Kuetzing) Manza ssp. *australica* ssp. nov. The former was first described by Harvey (1849), and the latter is a new subspecies of a species that is common in South Africa. Neither entity is common in south-eastern Australia and neither has been collected west of Eyre Peninsula.

The genus *Arthrocardia* is closely related to *Corallina*, a genus that is much more widely distributed and probably more primitive. Within Arthrocardia differences have evolved in the organization of the fertile branches. In both genera the conceptacles are axial, but in Arthrocardia fertile intergenicula all have the propensity for bearing branches, no matter what the reproductive type. These branches usually consist of more fertile intergenicula and, hence, a branching system of several fertile intergenicula develops. In *Corallina* the fertile intergenicula typically lack surmounting branches, although in carposporangial plants, and less often in tetrasporangial plants, they are occasionally present. Fertile intergenicula in male plants of *Corallina* invariably lack branches.

KEY WORDS: Articulated coralline algae, Corallinacae, *Arthrocardia*, southern Australia, Rhodophyta, marine algae.